

The dovetail shaped sliding lock plate contains a slot, referred to herein as a lock slot. This slot includes a conical shaped countersink located coaxially at one end of the slot. The lock slot allows a conical headed screw to pass through it and to be inserted into a threaded recess of the fixation plate to secure the sliding lock plate and limit its movement from one end of the lock slot to the other end of the lock slot. The sliding lock plate also contains cutouts and through holes to allow fixation fasteners to be placed through and into the holes in the fixation plate and in turn into the bone or graft material.

Sliding the lock plate to one end of the lock slot allows the cutouts and through holes to align with the fixation holes in the fixation plate. Sliding the lock plate to the other end of the lock slot allows the edges of the sliding lock plate to overlap over the holes in the fixation plate to secure the fixation screws and prevent the heads of fixation screws from backing out of the plate construct. It is when the sliding lock plate is slid to this position that the conical shaped countersink in the sliding lock and the conical headed lock screw align to cam the lock plate into position so as to lock down or fix the sliding lock plate into position in the fixation plate. Thus, the lock plate no longer slides relative to the fixation plate.

In a further embodiment of the invention, instead of using a lock screw to secure the lock plate into position, a spring biasing member is formed in the plate by forming a cut-out. The spring biasing member includes a boss which is held in a divot in the stabilization plate when the lock plate is in a first or "open" position so that the screws can be implanted. This divot is shallow enough to allow the plate to be easily pushed into the "closed" position where the boss encounters a deeper lock hole, which locks the plate, and thereby also the screws into position. The head of the bone anchor screws have a special step cut around the top to allow room for the lock plate without requiring the screws to be driven to an exact depth.

BACKGROUND OF THE INVENTION

Orthopaedic implants have evolved into many types of devices to assist in arthrodesis and correction of bone defects of a congenital, degenerative, or trauma related nature. Among the various types of orthopaedic implants are plate type devices. Plate type devices, like most devices, with the exception of endoprotheses, are temporary devices attached to stabilize two bone fragments or two bones, such as vertebra, until healing of the fragments or fusion of the two bones has occurred.

These devices are designed to be load sharing rather than load bearing. Load bearing devices typically carry all or bear all the stress. This is sometimes referred to as "stress shielding". Load sharing transfers some amount of the stress from the device to the bone itself. This transfer of load to the bone causes stress and this stress becomes the mechanism that triggers the body to start the healing or fusion process.

Some applications require different types of fastener devices, such as screws, pins, staples, or cerclage wire, in conjunction with the plate devices to secure them to the bone to provide the required stabilization.

Many fasteners are designed specifically for the two different types of bone within the body.

The two types of bone are cortical and cancellous bone. Cortical bone is typically the hard, dense shell of the bone that provides the structural strength. Cancellous bone is the more spongy and soft bone located inside the cortical shell as part of the marrow of the bone, which provides the blood supply and nutrients for the bone.

Due to the hard, dense shell cortical bone is typically more stable for the placement of screws for fixation. Cancellous bone is weaker compared to cortical bone. Screws designed for fixation in cortical bone are typically placed through one cortex, through the cancellous or marrow, and into the far cortex of the bone. This is referred to as bicortical screw fixation. Screws designed for cancellous bone are typically designed with a buttress type thread to be able to put as much material as possible between successive threads to increase the shear area in the cancellous bone. Cancellous screws are typically placed through one cortical wall and sized in length such that the end or tip of the screw does not encounter the cortex on the far side of the bone but ends in the cancellous structure. Cancellous screws may be used instead of cortical screws when penetrating the far cortex is not preferable. In some cases, penetrating the far cortex may result in damage to arterial or neurological structures. However, one concern of screws placed unicortically into cancellous bone can be the tendency for

the screw to "back out" from the plate device under cyclic loading and/or osteoporotic conditions or due to poor quality of the bone.

Devices used in applications involving the fusion or arthrodesis of two bones, such as the vertebra, require the cartilaginous material to be removed between them and the bone surface abraided to encourage a bleeding surface. Blood supply from the bleeding surfaces are required in order for the bone to fuse. Fusion of a joint involves removing the cartilaginous material in the joint and requires the cartilaginous surface of the articular joint to be abraided to encourage a bleeding surface for fusion. Fixation and stabilization must be adequate for the time required for a fracture to heal or two bones to fuse.

In certain applications where the devices are used in close proximity to a joint, the device should be designed such that it does not cause damage or have adverse effects to the articular surfaces of the joint. Further considerations of implant design should also be given to ensure that ligaments and tendon structures, usually located close to the joint, that come into contact with the implant are not compromised in any way by excess material, rough surfaces, or sharp edges. The profile of the present plate construct has been designed with these considerations.

SUMMARY OF THE INVENTION

In one embodiment, an anterior cervical plate assembly is provided with a fixation plate having exterior flanges each having a spherical counter sunk through hole to receive a cancellous screw for fixation. Recessed cutouts between these flanges provide for an increased ability to view the implantation site during fixation. These cutouts also allow easier bending by reducing the cross section of the plate. Further, the plate may include an additional aperture for fixation of a graft screw in the event a graft is used with the invention. Additionally, the top surface of the plate includes a channel defined by opposing undercut flanges, which form a sliding dovetail connection with mating edges of a locking plate. The locking plate further includes openings located to correspond and give access to the cancellous screw openings of the fixation plate when the locking plate is in a first position. This position is defined by a lock slot which receives a swaged lock screw, secured in the fixation plate. The locking plate can be slid to a second position where it does not overhang the fixation plate, and which is defined by the other end of the lock slot. In this position, the lock screw encounters a counter sink so that it can be tightened into a flush position relative to the top of the locking plate. The screw head includes a corresponding bevel to bias the locking plate into the second position in the countersink of the locking plate. Further in the second position of

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the locking plate, the bottom surfaces surrounding the edges of the cancellous-screw apertures now press against the top surfaces of the fixation plate surrounding the cancellous screws apertures. This blocks the heads of the cancellous screw from backing out of their apertures and locks them into position in the plate. The graft screw is, likewise, locked into place by the single sliding motion of the locking plate.

In a further embodiment of the invention, the locking plate has a leaf spring formed in it by cutting a u-shape in the central portion of the plate. The spring has a boss on its bottom side which interfaces with a lock hole in the plate to lock it into the closed position, and with a shallower divot to hold the lock plate in an open position. The screws also have a step cut to allow more clearance for the plate.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is perspective view of a first embodiment of the invention;

Figure 2 is a top plan view of the invention of Figure 1, with the locking plate in a first position;

Figure 3 is a cross-section of the invention of Figure 2 taken along line 3-3;

Figure 4 is a top plan view of the invention with the locking plate in a first position;

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Figure 10 is a side plan view of the embodiment of Figure 8 with the superior and inferior screws in a second position;

Figure 11 is an end view of the embodiment of Figure 8 plate into the second position;

Figure 12 is a top perspective of a further embodiment of the invention with the lock plate in a closed position;

Figure 13 is a top exploded view showing the stabilization plate and the lock plate;

Figure 14 is bottom exploded view showing the assembly of the present invention; and

Figure 15 is a side view of the anchor screw in accordance with a further embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

As can be seen in Figure 1, a bone fixation assembly is shown generally at 10 and includes a fixation plate 12 to be secured in an appropriate orthopedic setting by fastener means which are specifically cancellous screws 14, but could include other mechanical fixation means. Specifically, a fixation plate 12 includes exterior flanges 16 having spherical countersunk through bores 18 which receive the cancellous screws 14. The plate 12 also includes an aperture 21 for a graft screw.

Between each of respective flange pairs, the plate includes an undercut 15 to give the surgeon better viewing access to the implantation site. The top surface of the flanges are slightly tapered and rounded in order to minimize hard edges and as well as unnecessary material. Further, as can be seen, the fixation plate includes a slight arch along its longitudinal length in order to best accommodate a vertebral application in particular, for anterior application in the cervical spine. Thus, the curve is a sagittal curve. . The plate can be presented in various lengths expanding from 2 - 5 vertebrae.

On its upper surface, the fixation plate includes a channel 30, which is defined by opposing flanges 32, 34 each having an undercut 36 - 38, which will provide for a dovetailing connection with a corresponding edge 41, 42 of a locking plate 40. It can be envisioned

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to the openings 18 for the cancellous screws in the fixation plate. In the second position, as can be best seen in Figure 5, the bottom surface of the locking plate 40 in the vicinity of the opening 18 overlap the cancellous screw holes so as to restrain the screws from backing out of the fixation plate. A similar opening 74 is provided for the graft screw, which is available in the internal portion of the plate. Thus, it can be seen, that when the locking plate is slid from its first position to its second position, a plurality, and in fact all, of the screws of the fixation plate can be locked into position.

Figures 12-14 illustrate a further embodiment of the invention and more specifically show a bone fixation assembly is shown generally at 110. The assembly includes a fixation plate 112 to be secured by fastener means which are specifically cancellous screws 114, but could include other mechanical fixation means. Once again, the fixation plate 112 includes exterior flanges 116 having countersunk through bores 118 which receive the screws 114.

The fixation plate includes a central longitudinal channel 130, which is defined by opposing flanges 132, 134 each having an undercut 136, 138, which will provide for a dovetailing connection with a corresponding edge 141, 142 of a locking plate 140. Thus, the locking plate is captured by and slides in the central channel 130.

Locking plate 140 further includes a series of semi-circular open areas 170, which correspond when the locking plate is in its first position to the openings 118 for the screws. In the second position, as can be best seen in Figure 12, the bottom surface of the locking plate 140 in the vicinity of the openings 118 overlap the screw holes so as to restrain the screws from backing out of the fixation plate.

The locking plate also includes a snap lock locking mechanism, which includes a leaf spring 153 formed by u-shaped slits 150 in the lock plate. An enlarged recess 151 in the bottom of the U allows room to lift the leaf spring 153 upward to disengage the locking mechanism. The leaf spring includes a boss 155 on its bottom surface, which snaps into a through hole 160 in the lock plate to lock the plate into the closed position. There is also a divot 161, which is shallower than the hole 160, which captures the boss. This holds the plate in an open position of the lock plate where the screw holes are accessible to the surgeon. However, the boss can be disengaged by sliding it forward past the divot into the hole.

Also the further embodiment includes a step cut profile for the screw, which has a lower profile. The head has an exterior flange 156, which surrounds the head which projects upward beyond the flange to form the portion of the screw, which is captured by the lock plate. The

corner of the lock plate engageS the upper edge surface of the screw head.

Once the surgical exposure is complete and the final size implant is chosen, the implants are secured and fixated by use of the required instrumentation. Initially, appropriately placed and sized holes are tapped for screw placement.

Once tapping is complete, the appropriate length screw is chosen and attached to the hex of the screwdriver bit and the screwholder is applied to hold the screw until placed.

The screw is then placed through the holes in the plate and then advanced until the head of the screw is securely seated in the spherical countersink of the plate. This procedure is repeated for the number of screws being placed or required for secure fixation.

The graft screw is then placed through one of the holes along the centerline (sagittal plane) and then advanced until the head of the screw is securely seated in the spherical countersink of the plate in order to secure graft material, whether autogenous, allograft, or substitute.

The vertebral screws and the graft screws are secured in the bone and plate by advancing the lock plate until the conical head of the lock screw lines up with the conical countersink in the lock slot of the lock plate. The lock screw is then advanced until seated. The screws will

not back out of the plate once the slider plate is in position due to the plate overlapping one edge of each hole.

Once all plates and screws are secure according to the preoperative plan, wound closure can proceed by or under the direction of the surgeon.

While in accordance with the patent statutes the best mode and preferred embodiment have been set forth, the scope of the invention is not limited thereto, but rather by the scope of the attached claims.